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New York (State) University


# Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 500 ALBANY, N. Y. AUGUST 1, 1911


# FARM MECHANICS AND DRAWING

# SYLLABUS FOR SECONDARY SCHOOLS

## 1911


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*The oval shaped thus, O, or inverted O is used in the following letters.*

*abcdegbjmnpqr*

W. D. McJennett Del.

PLATE I

# Education Department Bulletin

**Published fortnightly by the University of the State of New York**

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No. 500 ALBANY, N. Y. August 1, 1911

# FARM MECHANICS AND DRAWING SYLLABUS FOR SECONDARY SCHOOLS

1911

This syllabus is designed to outline and direct the work that has been indicated as "Mechanical drawing" and "Carpentry and joinery," in the first high school year of the vocational course in agriculture. The drawing exercises are intended to occupy a regular recitation period of forty-five minutes three times per week, alternating with two laboratory periods of ninety minutes each devoted to shopwork in simple farm mechanics. The purpose of the year's course is to give students of agriculture the ability to design and draw, and then work out much of the rough carpentry, simple blacksmithing, repairs and other forms of mechanical work often needed about the farm and its buildings, and which every first-class farmer should know how to do and direct.

## MECHANICAL DRAWING

In its relation to the arts, mechanical drawing has for its object the conveying of information for purposes of construction. Its chief essentials are, therefore, a presentation of facts of form and dimensions which are embodied in what is technically known as the "working drawing."

Like most other subjects, mechanical drawing combines both theory and practice and has its conventions and rules of practice. While the theory is recognized as of great value in contributing to general educational growth and development yet the results attained must be judged by the ability to represent with accuracy and precision any desired object. The *working drawing*, therefore, must be regarded as the backbone of mechanical drawing, and too much emphasis can not be placed upon the importance of acquiring skill and rapidity of execution coupled with a knowledge of conventions and drafting technic.

For purposes of convenient explanation the subject has been arranged under the following subdivisions:

*a* Use of instruments
*b* Simple working drawings
*c* Geometrical constructions with carpenter's square

*a* **Use of instruments.** A large part of the work in constructive drawing requires the use of instruments. A proper selection of these should be made in accordance with the recommendations which are usually found in the standard textbooks on this subject. The care and use of the instruments and information in regard to supplies as well as general instructions are fully treated in the texts to which the teacher is referred. A list of approved texts, reference books, and equipment may be found on pages 26-29.

Satisfactory results in drawing are attained only by strict attention to details. Every drawing should be penciled in fine, light lines using a lead not softer than 4H and properly sharpened. A hard, firm paper that will withstand erasure should be used. A poor eraser will ruin a good drawing; the best is not too good.

Problem work should be left in pencil. Working drawings may be inked on paper to secure practice but most of the inking should be done on tracing paper or cloth in accordance with the method and practice of the modern drafting room.

*b* **Working drawings.** The first consideration in the making of a working drawing is the proper selection and arrangement of views. The number of views required depends altogether upon the nature of the object to be drawn, but should be as few as possible. It is wrong to suppose that three or any given number of views are always required. For example, an ordinary plain box may be represented generally in two views and simple turned pieces require but a single view while the cylinder need not be shown in a drawing at all; the statement that a cylinder 2 inches in diameter and 8 inches long is wanted conveys complete and accurate information without the aid of views. The rule is, therefore, to make only the *necessary* views.

As to arrangement, the top view should be shown above the front view; the right side view to the right and the left side view to the left of the front view. Bottom and back views are not frequently used, but when drawn should be placed to conform with the above scheme, the back view being placed to the right or left of side view. Sectional views should also follow the same plan. Related views must be included between the same parallels and under no circum-

Fig. 1 VISIBLE LINE.

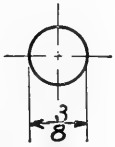
Fig. 2 INVISIBLE LINE.

Fig. 3. CENTER LINE.

Fig 4. EXTENSION, DIMENSION LINES. 5 FT. 3"

Fig. 5. CONSTRUCTION LINE.

Fig. 6.



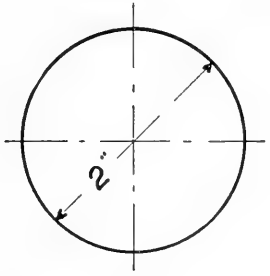
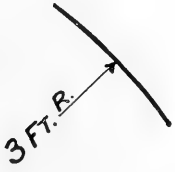




Fig. 7.



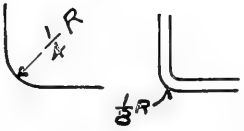




Fig 8.

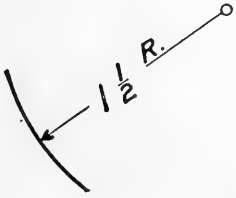
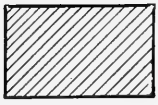
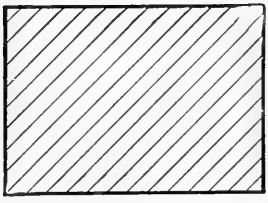



Fig 9.





W. D. Mc Jennett Del.

PLATE 2

stances should views be interchanged, reversed, or interposed between related views. (Some good suggestions are found in "Bench Work in Wood," pages 1–6.)

It is essential to keep in mind the fact that the working drawing is intended for the purpose of conveying accurate information and the crucial test requires that the information shall be distinct and complete as well as accurate. In order to meet these requirements it is often necessary for the draftsman to take liberties by omitting lines, views or parts of views. This may be termed *drafting license* and it simply means that for the sake of clearness the draftsman may depart with propriety from the strict theory of projection. From this practice has developed the necessity for the adoption of certain standards of usage which may be understood by draftsmen generally. The *conventions* which are given below are the more fundamental ones in general use. There is no code of standards which can be set up for universal adoption as the great diversity of the industries requires modifications and adaptations to individual requirements.

## Conventions and rules of practice

(See plates 2 to 5)

1 Visible edges and outlines of objects should be represented by full lines of medium width. (See figure 1)

2 Invisible edges and outlines of objects should be represented by broken lines consisting of short dashes of the same width as full lines, separated by spaces of about one-half the length of dashes. (See figure 2)

3 Center lines and lines indicating the position of the plane in which a sectional view is to be made should be broken lines consisting of alternate short and long dashes. (See figure 3)

4 Extension lines which project from points between which dimensions are to be expressed should be fine, broken lines consisting of dashes of medium length. Such lines should not touch the outline of the object, and should extend slightly beyond the point of the arrowhead on the dimension line. (See figure 4)

5 Dimension lines should be fine, broken lines, consisting of long dashes, interrupted for the figures expressing the dimension. These lines should be determined by arrowheads whose points touch the proper extension lines. (See figure 4)

6 Construction lines including all lines which are in the nature of diagrams and are not essential outlines or edges of the object represented should be fine dotted lines. (See figure 5)

7 Fine full lines in red ink may be substituted for broken center, dimension, extension and construction lines, except that in drawings which are traced for printing the broken lines in black ink are to be preferred.

8 Figures should read from the bottom and right-hand side of the drawing.

9 Dimensions of length should be placed below rather than above the view, and rarely, if ever, upon it. Dimensions of width should be placed at the right rather than the left. Minor dimensions may be placed on a view.

10 Over-all dimensions should always be given and placed outside all subdimensions.

11 Dimensioning from invisible edges should be avoided when possible.

12 Dimensions should read toward the center of circles, and never toward the circumference.

13 Circles are dimensioned by their diameters and arcs by their radii. (See figures 6, 7, 8)

14 Section lines should be broken for a dimension placed in a sectional area. (See figure 27)

15 Dimensions should be placed on one view if possible and should never be repeated.

16 Fraction lines should not be inclined.

17 Dimensions should never be placed on center lines and never be crossed by a line.

18 When the greatest dimension does not exceed 2 feet, figure the whole drawing in inches, omitting the ″ (inch marks).

19 Denote feet and inches thus: (*a*) 6′–10″, (*b*) 6 ft. 10″, (*c*) 8 ft. 0¾″.

20 Subdimensions should be chosen with reference to the measurements which will be made in constructing the object.

21 Dimensions should indicate full size independent of scale.

22 Sections should be shown by fine diagonal lines, spaced in proportion to the area of the section. (See figure 9)

23 When the object is symmetrical one-half only may be sectioned unless the section is small. A section of a symmetrical piece should be made symmetrical. (See plate 7)

24 Indicate the place at which a section is taken.

25 Select such views as will best show the object but as few as will show it clearly, using sections and details in preference to other views.

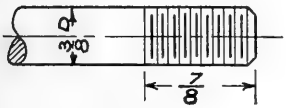



FIG. 10

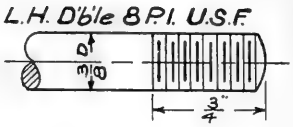



FIG. 11

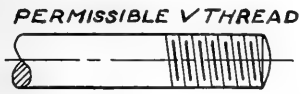



FIG. 12

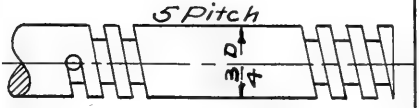
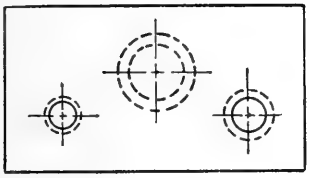



FIG. 13

FIG 15



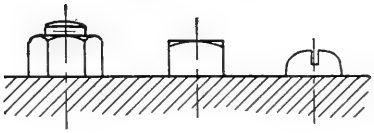
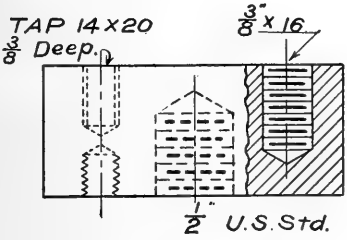


FIG. 14



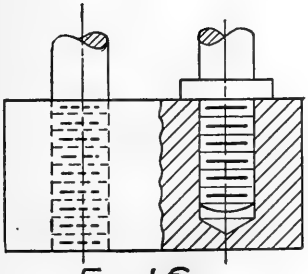



FIG 16

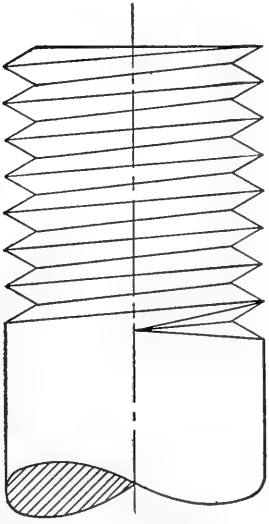


FIG. 17

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PLATE 3

26 Drawings should be made to as large a scale as possible. In no case should other than a standard scale be used. Standard scales are 12″, 6″, 3″, 2″, 1½″, 1″, ¾″, ½″, ⅜″, ¼″, 3/16″, ⅛″, 3/32″=12″. Details should be drawn full size, or to as large a scale as may be convenient.

27 A view may be omitted where a note will serve instead, and a view which shows circles only should be omitted, placing "D" or "Dia." (diameter) after the circular dimensions.

28 Tinting, shading and shade lines are not to be used unless the object shown is of such a nature that its construction is made clear in no other way.

29 Drawings of castings should be figured for the machinist, not for the pattern maker.

30 Never section bolts, nuts, screws, shafts, spindles, keys, gear teeth, arms of wheels (lengthwise), etc.

31 U. S. Standard and V threads should be represented as shown in figure 10. The lines need not be spaced with reference to the pitch of the screw represented.

32 The form of the thread, if other than the usual, should be stated in a note. The diameter and pitch of a screw should always be given. If a screw has a left-hand or multiple thread a note should call attention to the fact. (Figure 11)

33 Parts that are well represented in one view may be omitted in the others — such as bolts and screws, the location *only* being shown in the other views.

34 As far as possible drawings of related parts should be kept near together.

35 Each drawing should have a title placed in the lower right-hand corner. The title should state the name of the object, scale, name and location of firm, date, and name of draftsman.

The drawings made in this course need not be "inked in" except such as are to be traced and blueprints made from the tracings.

No drawing shall be placed before the student that is not in itself a model of good workmanship. It may sometimes happen that the school in which the agricultural course is established has already in service a special teacher of drawing and that the agricultural teacher is not specially skilful in drawing. In such cases this work may be conducted by the drawing teacher; but the agricultural teacher will be held responsible as to *what* is drawn. It must be definitely related to the vocational work which the student is doing in the shop and in the other special agricultural courses.

The pupil should at the outset be introduced to a high standard and encouraged to acquire a good drafting style. Pupils should be taught to work with facility from drawings, data, and from sketches of their own as well as those from other sources. In the matter of sketching it should be understood that the purpose of the technical sketch is to serve as a memorandum and it should be neatly and accurately drawn. Therefore the use of a straight edge or cross-section paper may be employed. In the making of a working sketch as well as the finished drawing a systematic method should be followed: (*a*) The size and arrangement of views and details should be such that the sheet is filled without being crowded. (*b*) After the views are "blocked in" they should be outlined lightly. In sketches it is desirable to draw the views in good proportion. (*c*) The details should next be worked up. (*d*) Then place all dimension lines and lastly the dimensions. In sketching, the scale should not be used and no measurements taken until the drawing is completed and all the dimension lines drawn. It must be impressed upon the pupil that for purposes of construction, the length, breadth and thickness of every part of the object and of every detail are absolutely necessary, and it should be required that each drawing be systematically made and thoroughly checked for these dimensions.

The lettering of a drawing is of the greatest importance. The style used should be plain and simple. Fancy lettering, elaborate borders and ornate embellishments of all descriptions should be studiously avoided; such features are not only in poor taste but they detract from, rather than add to, the usefulness for which a working drawing is intended. Letters and figures should average from $\frac{1}{8}$ inch to $\frac{1}{4}$ inch in height and should be formed and spaced in accordance with a few simple fundamental principles. All lettering should be done free-hand and each student should be encouraged to acquire a good lettering style. A vertical or slanting type of letter should be chosen and the choice once made should be uniformly followed and practised until good style and proficency are secured. Plate 1 furnishes a model of a simple style of lettering. Sufficient practice should be had before this plate is executed to enable the students to acquire fair speed and accuracy in such work.

When this portion of the course is finished students should have so far mastered the principles and practice of good lettering, both on drawings and sign boards, that it would be impossible for them thereafter to be guilty of such errors as dotting a capital I, turning

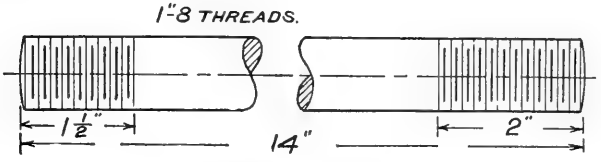


FIG 18 STUD.

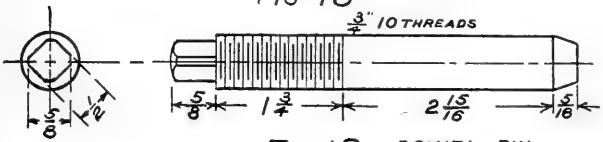


FIG. 19 DOWEL PIN.

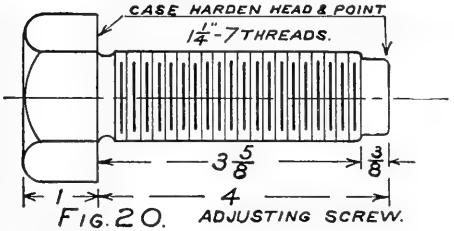


FIG. 20. ADJUSTING SCREW.

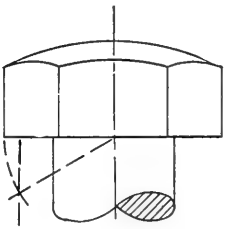

FIG 23.

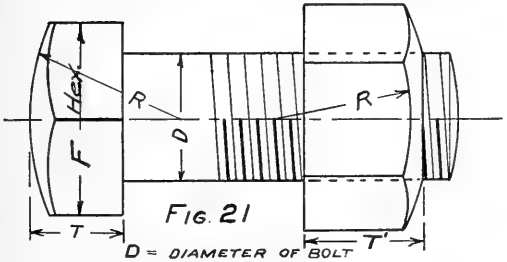


FIG. 21

D = DIAMETER OF BOLT
F = 1 1/2 D + 1/8"
T = F/8 T' = D
R = 2D OR 2 1/2 D.

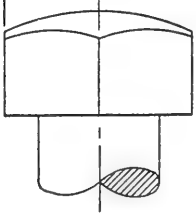

FIG. 24

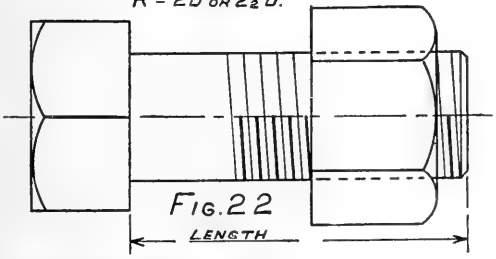


FIG. 22

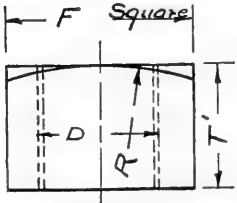


FIG. 25

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PLATE 4

the S, Z or N the wrong way, inverting the W to serve as an M, or promiscuously mixing capitals and small letters in the same word. Nothing else so marks one as unobserving and *illiterate* as this class of errors in signs and notices to the general public, as on letter boxes, for-sale signs, and advertisements of school meetings.

*c* **Geometrical constructions.** The majority of the students in this course will not have had plane geometry; but there are certain mechanical problems that anticipate a knowledge of technical geometry which can be worked out to great practical advantage through the use of the carpenter's square. This preliminary constructive work develops an appetite for geometry itself when the subject is properly reached in the course, and its use is in line with the most modern pedagogical principle, "application before theory." A variety of constructions are suggested in the following problems:

1 To draw a tangent to a circle
2 To find the center of a circle
3 To inscribe a hexagon in a circle
4 To trisect a right angle
5 To divide a quadrant into any number of equal segments
6 To find the "stretch-out" or length of a circumference
7 To determine a circle from three given points in its circumference
8 To construct an arc without using its radius
9 To construct an equilateral triangle
10 To construct a square
11 To construct an octagon
12 To bisect an angle
13 To divide a rectangle, as a board, into any number of equal parts without calculation
14 To construct an ellipse
15 To approximate the ellipse by using radii of circles, and by tangents
16 To lay out an arch, spiral, and parabola

These and other applications of "carpenter's geometry"[1] constitute a set of formal exercises that relate the drawing to actual construction work, and should occupy a reasonable portion of the time given to mechanical drawing. In addition, it is expected that all students in the course will execute plates which illustrate the principles included in plates 6-10.

[1] See Modern Carpentry, included in the book list on page 28.

## Making blueprints

When drawing and lettering have been well perfected, attention should be given to the process of reproducing known as blueprinting. A drawing of a printing frame should first be made, and the frame itself then constructed in the shop as a class exercise. It can be patterned after an ordinary photographer's printing frame, borrowed for the purpose, but made with larger dimensions, say about 16 by 23 inches inside. This frame should be fitted with a good clear pane of glass, and is then ready for use.

The drawings to be reproduced must first be traced on cloth tracing paper over good originals made on drawing paper. The tracing is placed *ink side down* against the glass and the print paper placed over it and held fast by the back of the printing frame.

The blueprint paper can be procured most cheaply by purchasing in rolls of 10 yards or more in any desired width, or in cut sheets. But it is useful to know how to prepare it in the laboratory. The following is a standard formula: Dissolve 2 oz. citrate of iron and ammonia in 8 oz. of water; also 1¼ oz. of red prussiate of potash in 8 oz. of water. Add ½ oz. of gum arabic to each solution. Keep these solutions corked in separate bottles in the dark room. (This may be built by the farm mechanics class if the school is not already provided, although the blueprinting can be done in an ordinary closet that excludes the light well.) The dark room should have a sink somewhat larger than any print to be made, about 6 inches deep, and provided with a loose, flat board cover.

When preparing the print paper, mix equal portions of the two solutions, and apply the mixture with a flat, wide camel's hair brush or sponge as evenly as possible. The sheets to be treated should be laid flat on the board and nailed through the two upper corners, and the board then set up in the sink at an angle of 60° from the horizontal. As each sheet is treated with the mixed solution it is pulled off by the two lower corners and laid in a drawer where it can be shut away from the light. All of this work and the filling of the frame for printing must be done in the dark room with as little light as possible.

After the printing frame is filled it is exposed to the perpendicular rays of the sun for from three to fifteen minutes. The best length of time may be determined by exposing to the sun a strip of the same paper drawn out an inch at a time at one-minute intervals from an opaque paper or pasteboard sheath. This strip is then "developed" in the regular way and that portion of it selected as a guide which gives the purest and most uniform blue color.

FIG. 26

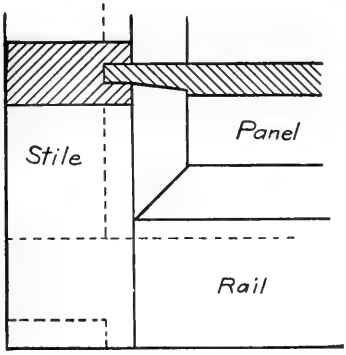



FIG. 28

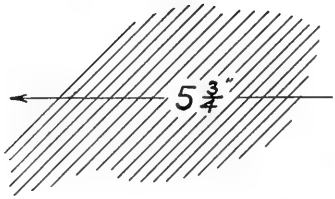



FIG. 27

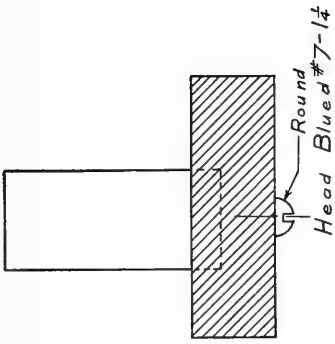



FIG 29.

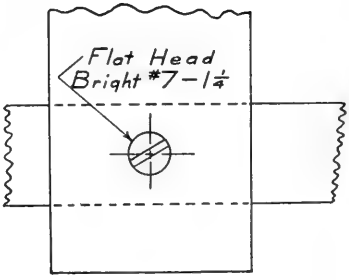



FIG. 30

J.E. Noll Del.

PLATE 5

When the printing is finished, the sheet is removed in the dark room and developed in the tray by soaking, *yellow side down,* in clean water for about ten minutes. The sheet is then taken by diagonally opposite corners, lifted out of the water, dipped several times until it becomes no bluer, and then hung on a suitable rack to dry. If any dark purple or bronze spots appear on it they should be thoroughly washed before the sheet is fully dry.

This blueprinting process can be used to excellent advantage in other work of the high school and lower grades, as in silhouetting butterflies, grasses, " skeletonized " leaves of trees, lace and embroidery patterns for sewing classes, etc. It is hoped that each class in farm mechanics will supply for exchange with all the other schools having agricultural courses a considerable number of blueprints of at least one of their best mechanical drawings each year. Several of these prints made in each school should be held for inspection and possible use by the Division of Vocational Schools.

## FARM MECHANICS

As previously indicated, the practical, experimental and observation work in farm mechanics is designed to occupy two laboratory periods each week throughout the entire school year. There is no intention that this work shall be an equivalent or substitute for the general manual training work outlined in another syllabus. The work here described calls for a different equipment, proceeds from another viewpoint, and is inspired by a much more concrete and definite vocational purpose.

### Equipment

On pages 26, 27 is given a list of the tools and other equipment considered necessary for an average class of ten students. The tools selected should be first-class in every respect. It does not pay the school or individuals to buy tools of an inferior grade. Better grades are always cheaper in the end, and what is still more important, they do not easily get out of order and thus hinder the student in his work. It is important that they should be tools of full men's size, suitable for use on any first-class farm. The use of smaller tools would easily bring the whole course into disrepute among practical school patrons; but this should not in any way discourage the purchase of small *sets* of standard tools by individual students. The individual chests for keeping such tools can well be made, from careful working drawings, by the students themselves.

As in the case of all other vocational equipment, the Education Department "duplicates" the cost of standard tools purchased by the school, and also the cost of books selected for the school library in farm mechanics and drawing, as well as in general agriculture.

**The shop room.** Under average conditions the room for shop-work can be found. It should be about 20 by 30 feet in area, well lighted, and preferably with a south exposure. Rooms not already suitable for the purpose may often be made so at small expense. If absolutely necessary a basement room may be fitted up. In this case additional windows will frequently be needed. If there is no concrete floor, the cement for making it can be mixed, tested, and laid under the direction of the vocational teacher (perhaps assisted by some local expert) as a regular exercise of the course in "mechanic arts."

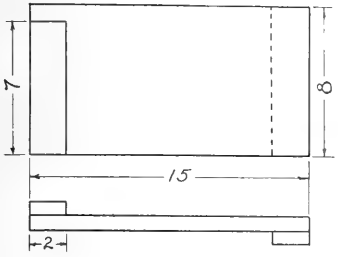
If the building has a gasoline engine or electric motor for ventilation, arrangements can often be made for extending its shaft or a counter shaft into the shop room, to be used for turning a grindstone, blowing the forge, or running a drill press or wood lathe.

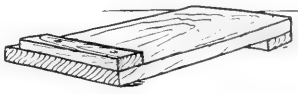
Under the row of windows there should be a continuous bench, preferably built by the students, of two-inch planks. This bench ought to be about 30 inches wide and from 25 to 30 feet long. It should be provided at regular intervals with five wood vises, to be made by the class after the iron screws, sockets and handles are supplied. (See plan in Farmers' Bulletin 347, page 23.)

At the end of the bench nearest the forge and anvil there should be one blacksmith's iron vise, and near by a blacksmith's drill press. A good grindstone, mounted by the students, can be placed in a convenient corner, and vertical cabinets for the tools belonging to the school can be built by the first class from their own designs. Some open space should be reserved in the middle of the room for the use of sawhorses, for setting up work in course of construction, and for testing the operation of gasoline engines. The forge should be so placed as to exhaust the smoke and gases into the regular furnace stack.

To deaden the sound of work being done in the shop, the ceiling of the room can be properly prepared, if desired, by the class in regular exercises. The under side of the floor joists overhead should be sheathed with "deadening felt," and this covered by a tight wooden ceiling or by lathing and plastering. Metallic ceiling should not be used because of its sound-conducting properties.

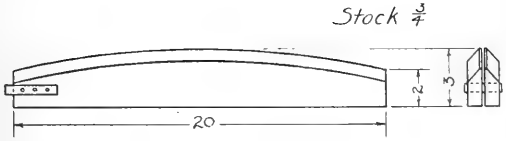
In some cases it may be advisable to have the shop detached from the school building, but near enough to be heated by the same sys-



Stock $\frac{7}{8}$ ·BENCH·HOOK·

FIG 31



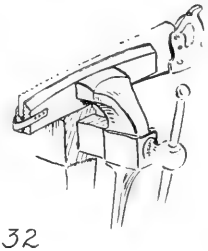
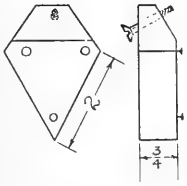



FIG 32




·FILING·GAUGE·

FIG 33

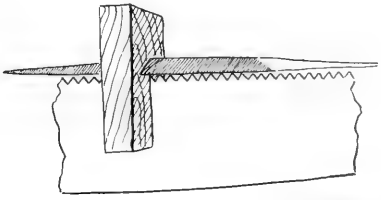
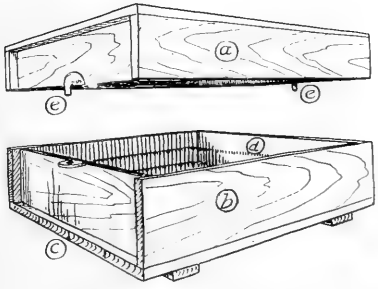


FIG 34




·MOLDING·FLASK·

ⓐ Cope
ⓑ Nowel or Drag
ⓒ Bottom board
ⓓ Grooves to hold sand
ⓔ Guide pins

FIG 35

PLATE 6

tem. Such a building can be designed, drawn, and largely constructed by the labor of the class. It may give good opportunity for making and laying concrete blocks or solid cement walls, patent roofing, tiles, cellular tile blocks, and other forms of modern building material that are very useful on the farm. In general, the work in farm mechanics is designed to give practical experience as well as educational direction in as large a range as possible of the various kinds of constructive and repairing work that have to be done, often without the service of expert craftsmen, under modern farm requirements.

### Practical exercise

**Sharpening tools.** One of the most important of the earlier practical exercises is in properly sharpening edged tools on the grindstone and oil stone. One method of grinding is illustrated in "Farm Conveniences," page 19, and a method of "trueing" a grindstone on page 18; see also pages 141 and 199. Some good suggestions are also made in "Handy Farm Devices," pages 10 and 284, in "Farm Appliances," pages 62–65, and throughout the book entitled "Bench Work in Wood." Sharpening the teeth of cultivators and harrows when worn adds greatly to their effectiveness. (See "Handy Farm Devices," page 271.) Valuable suggestions for the beginner on the care and use of bench tools may be found in Part I of "Elementary Woodworking." Part II of this book describes the various kinds of trees that are used for lumber making.

**Setting and filing saws.** The list of tools given on pages 26-27 provides for one saw set and saw-filing vise; ordinary flat and three-cornered files should be furnished by the students. Each can make for himself, after drawing, a wooden saw-filing clamp and setting gauge like those shown in plate 10. These can be used with the shop vises so that five or six students can work at the same saw-filing or setting exercise. Simple saw sets can be made on the anvil out of old files. One or two "jointers" (plate 10) should also be made, and practical work with all of these tools done both on handsaws and two-hand log saws. Good suggestions on the use of the file are found in "Farm Conveniences," pages 126–129, Farm Blacksmithing, pages 82–90, and "Bench Work in Wood," pages 26–41.

**Harness mending.** One of the most useful bits of skill often needed in an emergency is the ability to make quick repairs in harness. To assist in the development of such ability, the farm mechanics class should make for permanent use in the school shop one

of the harness clamps or vises that are designed for this purpose. Illustrations may be found in "Handy Farm Devices," page 262, in "Farm Appliances," pages 74, 75, and in other books and farm papers. In the first-mentioned design the weight of the user operates the clamp.

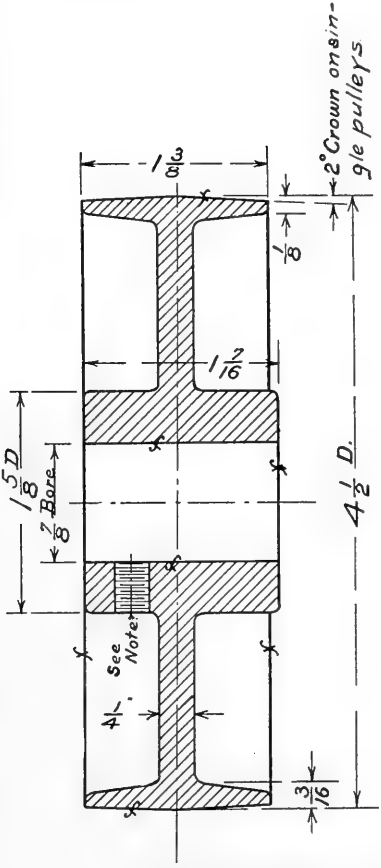
Pieces of broken harness should be brought from home to the shop, and the ingenuity of the class exercised in devising and executing the best methods of quick home repair. A practical suggestion for mending a broken tug is found in "Farm Conveniences," pages 24, 25; for protecting weak eyes in horses, on page 161; and for lengthening the wear of harness, on page 211. See also Farmers' Bulletin 347, pages 21, 22, 31.

The foregoing paragraphs illustrate the way in which reference books are to be used in all the practical work suggested or required in the course. Space does not permit in this syllabus an equally full description of all that is expected under the general divisions of carpentry, blacksmithing, and miscellaneous exercises. Accordingly only an alphabetical list of topics to be considered is here appended, followed by some explanation and comment.

## Suggestive list of topics

H. F. D.=Handy Farm Devices; M. B.= Modern Blacksmithing; P. A.= Physics of Agriculture; F. B.=Farmers' Bulletin; F. Bl.=Farm Blacksmithing; etc. see pages 28, 29.

1 Apple sorting table [H.F.D., p. 152]
2 Anvil foundation [H.F.D., p. 246; M.B., p. 33, 34]
3 .....
4 .....
5 .....
6 Babbitting [M.B., p. 114, 115; Cornell F. M. Ex. 2 (*see* p. 22)]
7 *Bag holders* [F.A., p. 57–60; F.C., p. 189, 205; H.F.D., p. 110, 111]
8 Bag tie [F.A., p. 8]
9 Barn doors (models) [F.C., p. 52; H.F.D., p. 184–187]
10 Barn frames (*models*) [P.A., p. 339–342; B.P.& O., p. 10–17, 61–66; *see also* plate 8]
11 *Barn plans* (drawings) [P.A., p. 366–378; B.P.& O., p. 10–17, 61–66; H.F.D., p. 198–204]
12 Barn ventilation [P.A., p. 350–365]
13 Barrel header [F.C., p. 20; F.B. no. 113, p. 30]
14 Belts [P.A., p. 543–545; M.B., p. 65, 66; F.M., p. 28–30]
15 *Belt lacing* (drawings) [P.A., p. 545, 546; M.B., p. 64, 65; F.M., p. 30–32; Cornell F. M. Ex. 1]




Note: Tap for 5/16" Std. S.S. on Tight Pulley.
Drill 3/16 oil hole. on Loose Pulley.

# WEB PULLEY

J. H. Moore Del.

PLATE 7

16 Bins for grain (models) [F.A., p. 26; F.C., p. 9]
17 Bird houses [B.P.& O. p. 314–323]
18 Bit-brace wrench [H.F.D., p. 11]
19 Blasting stumps and rocks [F.C., p. 57–62]
20 *Bridges, farm* (*models*) [H.F.D., p. 160, 161; F.G.B., p. 176–187]
21 Bull exerciser [F.C., p. 15]
22 Butter worker [F.A., p. 92; H.F.D., p. 51]
23 .....
24 .....
25 .....
26 Carts [F.A., p. 36; F.C., p. 111–113, 323]
27 *Cement concrete* [H.F.D., p. 214–231; P.A., p. 379–384; F.A., p. 45, 46; F.B. no. 235]
28 *Cement fence posts* (models) [F.B. no. 403]
29 *Chain links* [F.C., p. 122, 123; F.M., p. 33; F. Bl., p. 20–22]
30 Chicken coops (*models*) [H.F.D., p. 121–123; *also* "Poultry Architecture" and "Poultry Appliances"]
31 Cistern filter [F.A., p. 119 and H.F.D., p. 68, 69]
32 Clod crusher and sled [F.A., p. 49]
33 Cold frames [H.F.D., p. 140–142]
34 Colts, breaking rig for [F.A., p. 35, 36]
35 Corn rack (*models*) [H.F.D., p. 235–236]
36 *Corn testing tray* [F.B. no. 409]
37 "Corn Harvesting Machinery" [F.B. no. 303]
38 .....
39 .....
40 .....
41 Derrick, farm (models) [F.A., p. 147, 148]
42 Designs, elective (from all sources)
43 Drill press [F.B. no. 347, p. 16; F. Bl. p. 9]
44 Drilling iron [M.B., p. 58, 59]
45 Drilling steel [M. B., p. 118]
46 Dump sled [F.A., p. 45]
47 .....
48 .....
49 .....
50 .....
51 Egg carrier [F.C., p. 190–192; "Poultry Appliances"]
52 *Eveners* (*drawings*) [P.A., p. 497–499; F.M., p. 13–15]
53 .....
54 .....

55 .....
56 "Farm Conveniences" [*See also* F.B. no. 270]
57 Feed boxes and troughs [F.A., p. 8, 9, 11; F.C., p. 160]
58 Files and filing [F.Bl. p. 67–71]
59 Flood gates (models) [F.C., p. 107, 247; H.F.D.,p. 182, 183; F.G.B., p. 85–93]
60 Fruit picker [F.A., p. 177–179]
61 Foot-power device [H.F.D., p. 55]
62 Forge, portable [F.B. no. 347, p. 14]
63 .....
64 .....
65 .....
66 *Gasoline engines* (sectional models) [P.A., p. 523–530; F.M., p. 401–435, 456–459; Cornell F. M. Ex. 14]
67 Gasoline engines, fuel for [F.B. no. 277]
68 Gates, farm (*models*) [F.G.B., p. 117–164, and others]
69 Grain binder attachments [F.M., p. 150–153; Cornell F. M. Ex. 5]
70 *Greenhouse* [H.F.D., p. 209]
71 "Greenhouse Construction"
72 Grindstones [F.C., p. 17–19; F.A., p. 62–65; H.F.D., p. 10; B.W. in W., p. 66, 67]
73 *Grinding tools* [F.C., p. 141; B.W. in W., p. 24–26]
74 .....
75 .....
76 Hammer, nail-pulling [H.F.D., p. 246]
77 Harness clamp [F.A., p. 75; F.C., p. 24, 25; H.F.D., p. 262]
78 *Harness repairing,* tools and materials [F.B. no. 347, p. 21, 22, 31]
79 Heating vat [F.A., p. 34]
80 *Hinge, iron* [F.C., p. 38–40]
81 Hop poles, driving [F.C., p. 215, 216]
82 Hop trellising and tying (models) [F.B. no. 304, p. 13–17]
83 Horse power (model) [F.A., p. 153, 154; F.M., p. 287–294; P.A., p. 489–496]
84 Horseshoeing [F.C., p. 139, 140, 169, 170, 226; F.B. no. 179; F.Bl. p. 61–67]
85 *Hot bed* [H.F.D., p. 136–138]
86 *Hydraulic ram* [P.A., p. 552, 553; F.M., p. 273–276; F.B. no. 270, p. 7, 8; Cornell F. M. Ex. 7]
87 .....
88 .....
89 .....

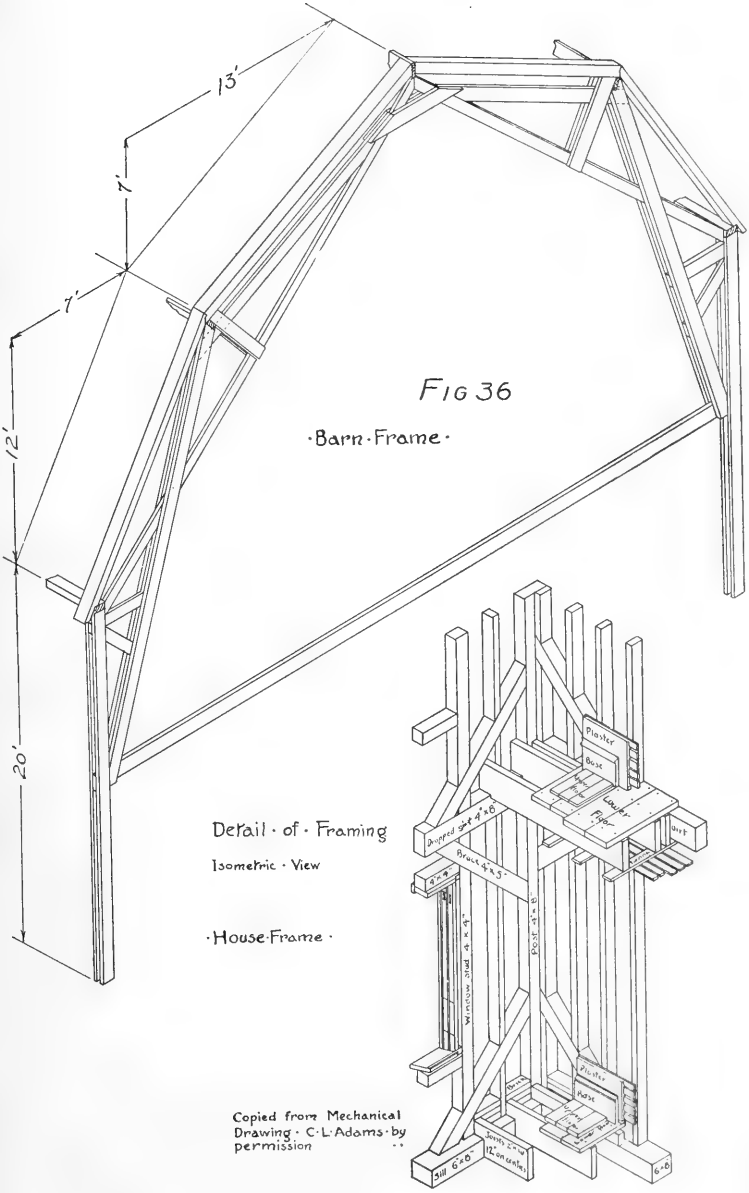



FIG 36

·Barn·Frame·

Detail · of · Framing

Isometric · View

·House·Frame·

Copied from Mechanical Drawing · C·L·Adams·by permission

PLATE 8

90 .....
91 Ice, *pan for freezing* [H.F.D., p. 233–234; *see also* figure 37]
92 *Implements,* farm (observation, setting up, use) [P.A., p. 225–37; F.M., p. 78–202; F. A., p. 124, 125]
93 Iron and steel, kinds of [F.M., p. 44, 45; M.B., p. 119; F.Bl. p. 11–16; 49, 50]
94 Iron, weight of one-foot lengths [M.B., p. 192; F.Bl. Appendix]
95 .....
96 Land measuring [H.F.D., p. 167, and others]
97 *Laying drain tile* [P.A., p. 321–328]
98 Level [H.F.D., p. 14, 15]
99 Leveling [P.A., p. 291–310, 312–320]
100 *Leveling, with a square* [F.C., p. 41, 42]
101 Lifting-jacks [F.A., p. 40; F.C., p. 154, 155]
102 Lifting hayracks [F.A., p. 38; H.F.D., p. 238, 239]
103 Lightning rods [F.B. no. 367]
104 *Lime, burning* [F.A., p. 159, 163]
105 Lubricating axles [F.A., p. 41, 42]
106 Lubricating shafts and machinery [P.A., p. 541, 542; F.M., p. 40, 399, 400, 428]
107 Lumber saving [Forest Service Circular no. 180, Washington, D. C.]
108 Lumber, testing strength of [B.W. in W., p. 198–200; P.A.; Forest Service Circular no. 113, Washington, D. C.]
109 .....
110 .....
111 Mail-box trolley [H.F.D., p. 71]
112 Milking stool [F.C., p. 46, and others]
113 *Miter box* [F.C., p. 129, 130; H.F.D., p. 24–26; B.W. in W., p. 63, 64; F.B. no. 347, p. 24]
114 .....
115 .....
116 Nails and tacks per pound [M.C., p. 193]
117 Nails for certain jobs, pounds needed [M.C., p. 185]
118 .....
119 .....
120 *Pattern and molding flask* [*See* plate 6]
121 Pig troughs [F.A., p. 22-25; B.P. & O., p. 154–186]
122 Pipe wrench, substitute for [H.F.D., p. 263]
123 *Plows, kinds and parts* [F.M., p. 52–70; P.A., p. 238–248; M.B., p. 109, 110]
124 Plows, *adjustment and use of* [F.C., p. 93]

125 Plows, draft of [P.A., p. 491; F.M., p. 73–75]
126 Plow, for snow [H.F.D., p. 241–242]
127 Potato sorter [H.F.D., p. 247]
128 "Poultry Architecture" [*See also* B.P.&O., p. 187–212]
129 "Poultry Appliances" [*See also* various bulletins]
130 Pulley, how to balance [M.B., p. 187; *see also* F.M., 32, 33]
131 *Pulleys and blocks* [F.M., p. 16–18]
132 Pumps, farm (sectional models) [P.A., p. 280–283, 246–552; F.M., p. 260–270]
133 Pumps, spraying [See catalogs and N. Y. Agr. Exp. Station Bulletin 121, Geneva]
134 .....
135 .....
136 Rabbit trap [F.C., p. 194, 195]
137 Rafters (*models, three pitches*) [H.F.D., p. 28–30; S.S., p. 29–38]
138 Recipes, mechanical [H.F.D., p. 273–282; M.B., p. 182; F.Bl. G. p. 14–16]
139 "Repair of Farm Equipment" [F.B. no. 347]
140 Repairing broken cogs [M.B., p. 116]
141 Repairing sickle bar [M.B., p. 114]
142 Road drag (models) [F.B., p. 321]
143 Rope belts [F.M., p. 34]
144 *Rope knots, hitches, and splices* (models) [H.F.D., p. 257–260; F.M., p. 35, 36; F.Bl. p. 71–81; Cornell F.M. Bull.]
145 Root cutters [F.A., p. 71–72; H.F.D., p. 113]
146 .....
147 .....
148 .....
149 .....
150 .....
151 *Sand-paper block* [F.A., p. 181]
152 *Saw filing and setting* [F.C., p.126–129; B.W. in W., p. 26–41; F.Bl. p. 82–90; *see also* figures 32–34]
153 *Saw filing clamp* [Plate 6]
154 Saw mending [M.B., p. 125]
155 Sawhorse [H.F.D., p. 13]
156 Sawhorse anvil [H.F.D., p. 11]
157 Screwdrivers [F.C., p. 141; B.W. in W., p. 59, 60]
158 Sheep-feeding racks [F.A., p. 18, 19; H.F.D., p. 95, 96]
159 Shop arrangement and equipment [F.M., p. 500, 501; M.B., p. 31–38; F.Bl. p. 6–10; F.B. no. 347, p. 26, 27]

160 Silo construction (*models,* stave or concrete) [P.A., p. 394–423; F.B. no. 32; Bureau of Animal Industry Circular no. 136, Washington, D. C.]
161 *Soldering* [H.F.D., p. 17, 18, 282, 283]
162 Split-log road drag (*model*) [F.B. no. 321]
163 Splitting rails and posts [F.C., p. 116–118; F.G.B., p. 95, 96]
164 Stable floor scraper [F.C., p. 180]
165 Stairs (models) [H.F.D., p. 31; S.S., p. 39–42]
166 Stanchions and ties (models) [F. A., p. 11, 13–16; H.F.D., p. 86–88; P.A., p. 384–388]
167 Steam engines (sectional models) [F.M., p. 364–400, and others]
168 Steel, annealing and tempering [M.B., p. 116; F.Bl., p. 52–57]
169 Steel, tensile strength of [M.B., p. 174]
170 Steel square, use of in "carpenter's geometry" [M.C., p. 33–44; H.F.D., p. 19–34; S.S. part I]
171 "Steel Square, The"
172 Stoneboat [F.C., p. 88, 89; H.F.D., p. 157, 158]
173 Stone fork [F.A., p. 68; *see also* F. C., p. 224]
174 *Straightedge* [H.F.D., p. 28]
175 Straw baler [F.A., p. 27]
176 .....
177 .....
178 .....
179 .....
180 .....
181 Table, folding [H.F.D., p. 50]
182 Tools, care of on farm [F.C., p. 51, 52]
183 Tools, fastening handles of [H.F.D., p. 15]
184 Tools, lists of [Bureau of Plant Industry Circular no. 44, Washington, D. C.]
185 Tools, combination sets of [F.B. no. 347, p. 24, 25]
186 Tools, marking with acid [M.B., p. 126]
187 *Tool table* (forging) [M.B., p. 34, 35]
188 Trap nests (models) [F.C., p. 135, 236; H.F.D., p. 119; "Poultry Appliances"]
189 .....
190 .....
191 Vegetable washer [F.A., p. 73]
192 .....
193 .....
194 .....

195 .....
196 Wagon, draft of [P.A., p. 434–443; F.M., p. 248–254; *see also* U. S. Yearbook Separate, "Steel Track Wagon Roads," 1898, Washington, D. C.]
197 Wagon seat [F.A., p. 41; F.C., p. 203, 204]
198 Wagon brakes, hubs, spokes, etc. [F.M., p. 242–248, 256]
199 Water filters [F.A., p. 113–115; H.F.D., p. 70]
200 Watering plants [F.A., p. 170]
201 Water trough [F.A., p. 28–32; F.C., p. 43, 44, 70]
202 Weed killer [F.A., p. 174]
203 Weeding stool [H.F.D., p. 144]
204 *Welding* [M.B., p. 55–57; H.F.D., p. 283–284; F.Bl. p. 35–38]
205 Wheelbarrow [F.C., p. 168, 253; H.F.D., p. 239, 240]
206 *Whiffletrees* [F.A., p. 69; F.C., p. 114; F.Bl., p. 43–45]
207 Windmills (*models*) [P.A., 531–537; F.M., p. 298–316; F.B. no. 270, p. 8, 9]
208 Wire splicer [H.F.D., p. 14; F.G.B., p. 59, 60]
209 Wire tightener [H.F.D., p. 155; F.C., p. 95; F.G.B., p. 55–58]
210 Wire fence corrosion [F.B. no. 239]
211 Wood, qualities of [B.W. in W., p. 158–182]
212 Wood splitter[H.F.D., p. 245]
213 *Wood vise* [F.B. no. 347, p. 23]
214 Work bench (models) [F.B. no. 347, p. 23]

## Class assignments

It is expected that all the reference books in the agricultural library will be *searched* for their treatment of *all* the topics in the foregoing list. A good exercise in connection with this is to assign one book to each two members in the class until every topic in the list is located, and then have the class as a whole construct one general index for the school. This index should be reconstructed independently by each new class so as to include all additions to the library made from time to time in the form of new books and bulletins.

All the *italicised* topics in the list are to be specially *studied* and *worked out* by the class. All italicised *models* and *drawings* are to be executed during the course. Where students prefer, a full-size construction may be made instead of a model. In general, all constructive work is to be preceded or followed by working drawings. These drawings constitute a regular part of the work in mechanical drawing during three days each week throughout the year.

In addition to these assigned topics, each student is expected to select, draw, and construct one or more designs that appeal particularly to his own interest (topic 42). Many suggestions for such constructions can be found by searching the reference books. Frequently the illustrations will stimulate the desire to make improvement on plans and devices described in the books. It is hoped that the student's own ingenuity and inventive ability, as well as good workmanship and the practical adaptation of the device to its purpose, will be exemplified in these productions. They should furnish a large percentage of the blueprints exchanged with other schools. Some of them can be used to good advantage in connection with the "home project work" in Agriculture VIII, which is treated in another syllabus.

Until a larger experience is developed in this course teachers are at liberty to follow their own judgment as to the *order* in which they take up the topics indicated. In all cases it is important, however, that the simpler exercises shall be mastered first so that the skill and experience thus derived may be used later in those more difficult of execution. Periodical inspection by the Division of Vocational Schools should serve to improve and harmonize the work in the various classes. The individual elective designs should be *chosen* early in the year, but plenty of time then taken to acquire the ability to work them out satisfactorily.

## Special suggestions

The assistance of local experts may often be enlisted in the practical work involved in certain topics, as for example those numbered, 2, 6, 11, 15, 19, 27–29, 34, 44, 45, 66, 69, 71, 73, 78, 86, 91, 92, 97, 100, 104, 120, 124, 127, 128, 133, 137, 141, 143, 144, 152, 160, and 186. The instructor should not hesitate to secure such assistance when possible from well-informed practical mechanics and farmers, and also from other teachers in the school. There is a distinct advantage to the class and to the course in enlisting the favorable interest of a large number of school patrons. While the instructor should never pose as one who always knows the ultimate facts on any topic, and should frankly acknowledge efficient assistance received from others, he should aim to know more of the science and literature of his subject, and if possible of its practical applications, than could be expected of anyone else.

In reference to topics 9, 10, 20, 35, 52, 59, 68, 107, 137, 160, 165, 207, and 214, a particular suggestion is here offered: It is desirable to procure a quantity of thin, clear, thoroughly seasoned

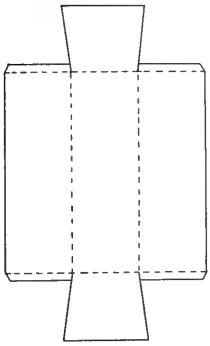
pine strips 24 inches in length, sawed fine enough to represent miniature lumber 16 feet long, 1 and 2 inches thick, and 4, 6, and 8 inches wide, on the scale of ⅛ inch to the inch. Thus an ordinary fence board would be represented by such a strip 24 inches long, ¾ inches wide, and ⅛ inch thick. This "model lumber" can be cut into suitable standard lengths by the students and kept in stock for the various model constructions indicated.

Thorough work, within the students' ability, should be done in topics 27, 28, 36 (with practical test), 52, 66, 73, 92, 100, 124, and 152. In connection with topic 27 students should be encouraged to devise some simple but fairly accurate test of the breaking and tensile strength of concrete of varying proportions of cement in both "dry mix" and "wet mix" sample briquettes 4 inches long and of 1 square inch section. (A similar suggestion is offered in reference to topic 108.) A cement foundation 2 or 3 inches thick can well be used for the model indicated in topic 82.

Special assistance in working out topics 6, 15, 66, 69, 86, and 161 can be had from the Department of Farm Mechanics of the State College of Agriculture. Send for *one set* of mimeographed direction sheets for each of these exercises, to use in connection with the book references. The sets corresponding to these topics are numbered as "Exercises" 1, 2, 5, 7, 13, and 14 (last on "Gasoline Engine Troubles") as arranged for college students. A special bulletin can be had from the same department on "Knots and Hitches" (for topic 144). Students will be individually expected to make one rope halter in this exercise.

If possible the class should undertake to make the model horse shown on page 493 of the "Physics of Agriculture," for the sake of carefully studying the facts and principles illustrated by it, in connection with topic 83. Topic 104 probably can not be practically illustrated in all localities, but where possible it will be useful to have the class actually burn a miniature kiln of lime-making material.

Topic 120 should be worked out in the shop as a class exercise, and if there is a foundry in the neighborhood, the flask and pattern (for some S-wrench that can be used in the shop, or some small broken casting to be replaced) should be taken to the molding room and the work of preparing it for casting demonstrated by an expert. The class should then see the casting made. Where no foundry is available small patterns may be run in lead melted in the babbitting pot, great care being taken to avoid any injury from the spattering of the molten metal.



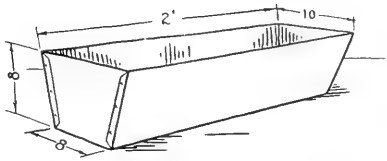
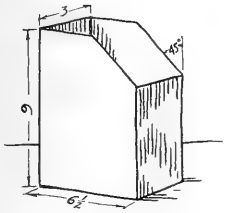



FIG 37.



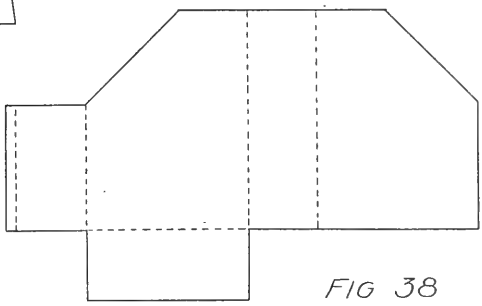
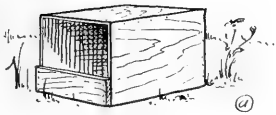
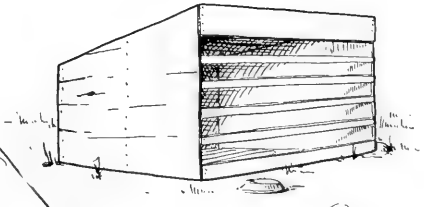



FIG 38



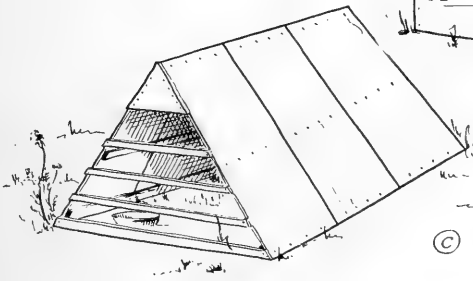




PLATE 9

In connection with topic 124, it would be well to arrange a plowing match, on measured ground, in which each member of the class should compete for a prize offered by local interest. Such a contest should be well prepared for by careful *study* and *practice*.

Topic 91 offers one opportunity for a little experience in practical sheet metal work. If possible each member of the class should make at least one such construction as shown in figures on plate 9. The form shown in figure 38 may be done either in sheet metal, giving opportunity for either soldering or clinching the joints, or in heavy pasteboard. Cases of either material may be painted or covered with binding cloth. These cases will prove useful for keeping bulletins in classified order in the school or home library and for filing clippings from agricultural papers.

If experience shall prove that the course of practical exercises here outlined is too long to be accomplished by the average class in one year, certain parts of it may be reserved as laboratory work in connection with other subjects that come later in the agricultural course. Topics 16, 22, 30, 34, 35, 36, 42, 51, 60, 69, 70, 71, 82, 83 (model), 85, 92 (for certain crops), 104, 112, 121, 124–129, 133, 158, 164, 166, 175, 188, 203, and 206 may, perhaps, be best worked out in this way: As previously stated, the purpose of the "mechanic arts" course in agriculture is to give students the ability to use, adjust and repair the various tools, implements and machinery required in modern farm operations, and to direct, if not actually to perform ordinary constructive work in improving farm buildings, grounds, and home conveniences.

## FORGE WORK

On all large and many small farms a portable blacksmith's forge, with anvil and a few of the more common tools, is frequently brought into service. This is especially the case in making emergency repairs on farm implements and harvesting machinery that may save hours and days of valuable time in planting or gathering certain crops. Some one who has a permanent interest in the farm should be competent to do such work; and until he himself succeeds to ownership the owner's son ought to "take care of" such work. When he becomes owner or manager he will then have had practical experience as to the way in which such jobs should be done by his assistants, if he does not prefer still to do them himself. The equipment for simple work of this kind on the farm need not be expensive. (See "Handy Farm Devices," pages 269–272, "Farm Blacksmithing," pages 5–9, and Farmers' Bulletin no. 347.)

The students in the farm mechanics class can do most of the work of installing the forge, anvil, fuel box, blower, tool table, drill press, and vise. (See "Modern Blacksmithing," pages 28–35, and other book references, and Farmers' Bulletin no. 347.) A good local blacksmith may be willing to assist in this and also to make in the school shop a number of the tools described in "Modern Blacksmithing."[1] pages 39–44, and "Farm Blacksmithing," pages 39–43; 47–49.

At least the following exercises should be worked out by all members of the class:

1 "Drawing out" round and square iron
2 Welding round and flat iron — lap welds, butt welds, and split welds
3 Forging chain links and hooks
4 Drilling cast and wrought iron and steel
5 Some elective work, as making a butcher's knife or a sawset out of an old file, making a punch or cold chisel, a riveting hammer, tongs or some other tool, or a chain hook, clevis, door hook, or some other construction needed on the farm.

The whole class should also have experience in soldering, and if possible in setting up and babbitting a shaft. The latter exercise should never be done, however, except with the utmost precaution against injury from the fluid molten metal. The face should always be shielded against possible explosion as the metal is poured into the box, and the latter should be thoroughly dried beforehand.

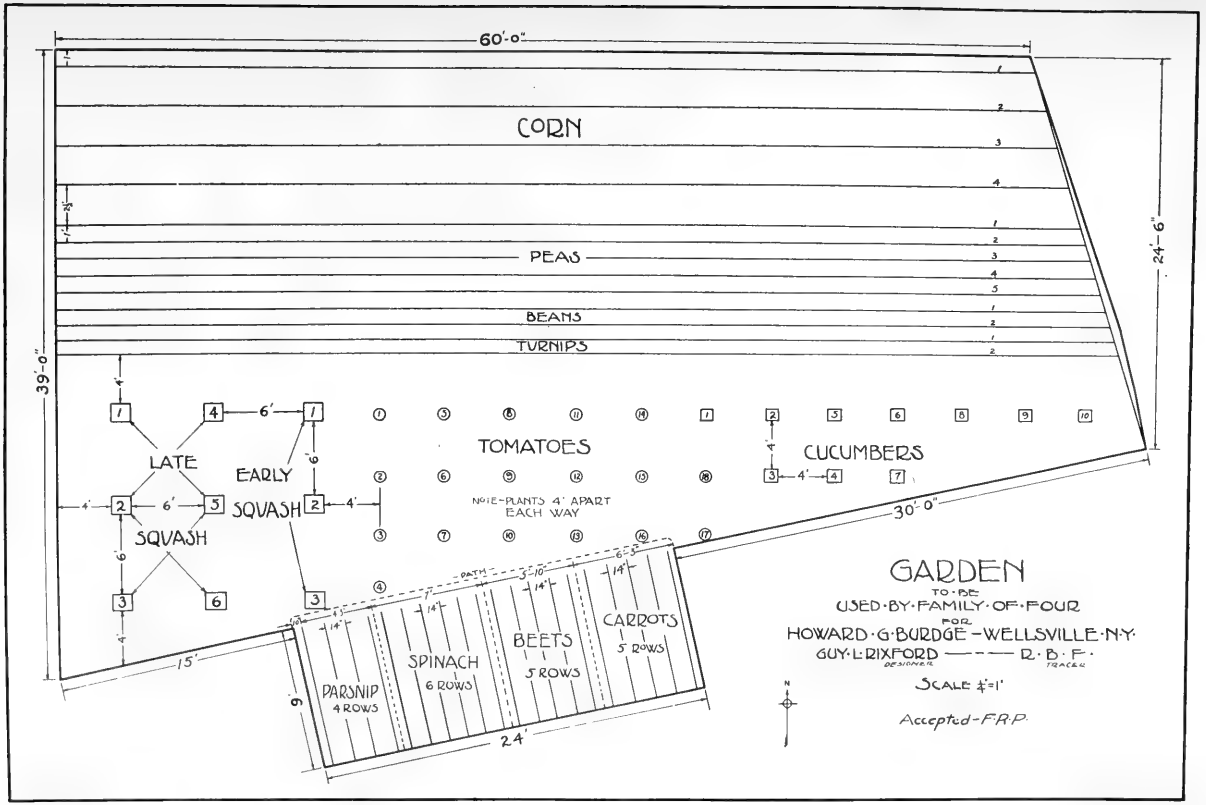
No attempt should be made to do horseshoeing in the school shop; but the Farmers' Bulletin on that subject should be carefully read, and the work of good horseshoers carefully observed, so that the students who finish this course will know when such work is properly done and how to detect injuries resulting from improper shoeing and fitting. (See also "Farmer's Cyclopedia of Live Stock," pages 165, 166 and "Farm Blacksmithing," pages 61–67.)

## GASOLINE ENGINES

The references on this subject should be carefully studied as to the various types of gasoline engines adapted to farm use, the principles on which they work, and the discovery and correction of

[1] This book contains a considerable number of topics that have no direct relation to blacksmithing, but it has also many valuable practical directions that should be compared with those in other books.

PLATE 10


60'-0"
CORN
PEAS
BEANS
TURNIPS
39'-0"
24'-6"
LATE
EARLY
SQUASH
SQUASH
TOMATOES
CUCUMBERS
NOTE-PLANTS 4' APART EACH WAY
30'-0"
15'
PATH
PARSNIP 4 ROWS
SPINACH 6 ROWS
BEETS 5 ROWS
CARROTS 5 ROWS
24'
GARDEN
TO BE USED BY FAMILY OF FOUR
FOR
HOWARD G BURDGE - WELLSVILLE N.Y.
GUY L RIXFORD DESIGNER — R B F TRACER
SCALE 1/4"=1'
Accepted-F.R.P.

"troubles." This study should be accompanied by practical experience in the handling of several engines borrowed from the manufacturers through the good offices of local implement dealers. If possible two or more engines should be available at the same time so that students can make their own comparisons between them after carefully studying and following directions given in the respective catalogs. The teacher should, of course, occupy a strictly neutral position as to favoring one engine more than another.

If some class or student can construct a working sectional model of a gasoline engine similar to those on pages 403–407 of "Farm Machinery and Farm Motors," it would add greatly to the clearness of instruction in this subject. Blueprints of such sectional models can sometimes be procured from manufacturers. A similar model is desirable for the steam engine. (See page 364 of the same book, and others.) All the parts in these engines should be thoroughly learned by their *technical names*.

Make use of the Cornell direction sheets on "Gasoline Engine Troubles" mentioned on page 22.

**Caution.** The gasoline tank of a portable engine should *never be filled within thirty minutes* before a class exercise begins nor during its progress. The testing of engines should always take place on a concrete or earth floor. All shavings, sawdust, or other litter should be swept at least eight or ten feet away from the engine, and gasoline should never be stored near or *carried over* such material. Where an underground gasoline tank is already installed outside the building, bring the gasoline by a pipe to the point where the engine is set up. This arrangement is always preferable, if not required by insurance regulations. Unburned charges from the engine must not be exhausted into the furnace stack or chimney. The exhaust may be conducted through an open hood to a point outdoors or into a section of large tile open at both ends, or allowed to discharge directly into the shoproom if ventilation is good.

The general study of steam engines and boilers is too large a subject to be undertaken in this course, but where opportunity offers the class should observe the workings of steam engines on the farm and in dairies and factories, and should understand their advantages over the gas engine for certain types of service. Possibly the class may be able to learn how to set an ordinary slide valve (get exercise 13 from the Cornell Farm Mechanics Department). At least the *names of parts* and the ordinary *types* of steam engines should be learned and identified by the class, as indicated in a preceding paragraph.

## FARM IMPLEMENTS

The general and special farm implements used in the neighborhood of the school and for sale by local dealers should be studied as fully as time permits. As already suggested, this may best be done in connection with the study of special crops. The cooperation of dealers can usually be secured in giving the class opportunity to see various implements unpacked from shipping cases and set up and adjusted for field use. The workings of any implement that is specially new to the district should be studied in the field and on the farms of users. The practical work and study involved in the entire course should develop a habit of mind that will lead to a much larger and more intelligent use of all means that may lessen mere muscular labor on the farm and make all work more effective and more interesting to the worker.

## EQUIPMENT FOR DRAWING AND SHOPWORK

### Individual instruments and tools

| | |
|---|---|
| 10 sets drawing instruments, including ruling pen, dividers and compass, with pencil and pen points, each | $1.25 |
| 10 bread boards (for drawing), 16″ x 20″, each | .30 to .60 |
| 10 rulers, each | .10 |
| 10 T-squares, to be made by students. | |
| 20 triangles, each | .20 |
| 10 bench hooks, to be made by students. (*See* figure 31.) | |
| 10 saw-filing clamps (wood) to be made by students. (Plate 6.) | |
| 10 scratch awls, 1½″ handled, each | .05 |
| 10 bevels, sliding T 6″, each | .25 |
| Total, per student | $2.45 |

### General tools for shop

| | |
|---|---|
| 1 bench, to be built by students. (*See* page 12.) | |
| 5 bench screws (vise), sockets, and handles, 15 x 1½″ | $6.50 |
| 5 bench stops | 1.50 |
| 1 bit set, dowel, 3/16″ to 15/32″ | 2.50 |
| 1 extension bit | 1.50 |
| 1 belt punch | .50 |
| 2 bit braces, 8″ sweep | 1.85 |
| 1 calipers, 10″ | .50 |
| 5 chisels, socket firmer, one each ⅛″, ¼″, ⅜″, ¾″, and 1½″ | 1.80 |
| 4 clamps, steel bar, to open 24″ | 1.90 |

| | | |
|---|---|---|
| 1 | countersink, rose, 5/8" | .30 |
| 4 | dividers, wing 6" | .67 |
| 1 | drawing knife | 1.00 |
| 1 | file, coarse mill, one round edge, 16" | 1.25 |
| 1 | drill press | 8.00 |
| 1 | file brush | .25 |
| 3 | gauges, marking | .25 |
| 4 | gouges, tang outside firmer, one each 1/4", 3/8", 1/2", 3/4" | 1.30 |
| 1 | hack saw, 16" | .65 |
| 1 | hammer, riveting, 7 oz | .55 |
| 1 | hammer, machinists', ball peen, 16 oz | 1.00 |
| 6 | hammers, bell faced, 13 oz | 2.65 |
| 1 | hand drill, with frame for bench use | 2.75 |
| 5 | hand screws, 9 1/2" | 2.45 |
| 5 | hand screws, 16" | 2.85 |
| 5 | levels, pocket, for use with square | 1.00 |
| 1 | melting pot for babbitting | .65 |
| 2 | oilers, copper 1/3 pt | .28 |
| 2 | oilstones, coarse and medium | .85 |
| 2 | planes, smoothing, 1 3/4" cutter | 2.10 |
| 2 | planes, double jack, 16" | 3.00 |
| 1 | plane, jointer, 24" | 3.40 |
| 3 | pliers, flat nose, 8" | 3.75 |
| 2 | rasps, wood, 10", one round side | .76 |
| 5 | saws, crosscutting, 26", 7 pts | 6.75 |
| 2 | saws, rip, 26", 7 pts | 2.70 |
| 1 | saw, compass 16" | .33 |
| 1 | saw, keyhole | .18 |
| 1 | saw set | .75 |
| 2 | screwdrivers, 7" | .63 |
| 1 | screwdriver, 12" | .65 |
| 1 | shears, tinners, 3 1/2" cut | 2.00 |
| 1 | soldering set, iron, torch, resin, bar solder | 5.00 |
| 1 | vise, saw-filing | .75 |
| 1 | vise, blacksmith's | 5.50 |
| 1 | wrench, monkey, steel bar, 12" | 1.00 |
| 1 | wrench, monkey, steel bar, 15" | 1.75 |
| | Total, subject to discount | $88.25 |

The blacksmith's anvil, portable forge (with hood), tongs, hammers, punches etc. may be bought second-hand, or made as sug-

gested on page 24. These tools and those in the list are usually handled by the large mail-order houses. Prices procured through local dealers in quantities sufficient to equip the school shop are subject to discounts. The totals given above may therefore be considered the maximum for the tools listed. The entire expense on which State duplication can be arranged for fitting up the complete workshop would probably not exceed $100 for the first year.

## TEXT AND REFERENCE BOOKS AND BULLETINS

Barn Plans and Outbuildings. Halsted & Powell. Orange Judd Co. . . . . $1.00
Bench Work in Wood. Goss. Ginn & Co. . . . . .70
Farm Appliances. Martin. Orange Judd Co. . . . . .50
Farm Conveniences. Orange Judd Co. . . . . 1.00
Farm Machinery and Farm Motors. Davidson & Chase. Orange Judd Co. . . . . 2.00
Farm Mechanic, The. Chase. Sturgis & Walton Co., N. Y. . . .75
Elementary Woodworking. Foster. Ginn & Co. . . . . .60
Elements of Mechanical Drawing. Anthony. D. C. Heath & Co. . . . . 1.50
Essentials of Woodworking. Griffeth. The Manual Arts Press, Peoria, Ill. . . . . 1.25
Farm Blacksmithing. Drew. Webb Pub. Co., St Paul. . . . . .50
Farmer's Tanning Guide, The. Stevens. Webb Pub. Co., St Paul . . . . . .25
Fences, Gates and Bridges. Martin. Orange Judd Co. . . . . .50
Greenhouse Construction. Taft. Orange Judd Co. . . . . 1.50
Handy Farm Devices and How to Make Them. Cobleigh. Orange Judd Co. . . . . 1.50
Home Water Works. Lynde. Sturgis & Walton Co., N. Y. .75
Letters and Letter Construction. Trezise. The Inland Printer Co., Chicago. . . . . 2.00
Mission Furniture: How to Make It. Part I, Popular Mechanics Co. . . . . .25
Modern Blacksmithing. Holmstrom. F. J. Drake & Co., Chicago . . . . . 1.00
Modern Carpentry. Hodgson. The Radford Architectural Co., N. Y. . . . . 1.00
Modern House Plans for Everybody. Reed. Orange Judd Co. . . . . 1.00
Physics of Agriculture. F. H. King. Pub. by Author, Madison, Wis. . . . . 1.75

Problems in Mechanical Drawing. Bennett. The Manual Arts Press ..... 1.00
Poultry Architecture. Fiske. Orange Judd Co..... .50
Poultry Appliances and Handicraft. Fiske. Orange Judd Co..... .50
The Steel Square. Part 1. Hodgson. Industrial Book Co., N. Y. ..... .50

### Farmers bulletins

No.
113 Apples and How to Grow Them
179 Horseshoeing
235 Preparation of Cement Concrete
270 Modern Conveniences for the Farm Home
277 The Use of Alcohol and Gasoline in Farm Engines
303 Corn Harvesting Machinery
304 Growing and Curing Hops
321 The Use of the Split-log Drag on Earth Roads
347 The Repair of Farm Equipment
367 Lightning and Lightning Conductors
403 The Construction of Concrete Fence Posts
409 School Lessons on Corn

### Circulars, etc

Forest Service Circular 113
Forest Service Circular 180
Bureau of Plant Industry Circular 44
Bureau of Animal Industry Circular 136
Yearbook Separate (U. S. Department of Agriculture) 1898
State Experiment Station Bulletin 121 and others, Geneva, N. Y.
Cornell Farm Mechanics Exercises 1, 2, 5, 7, 13, 14, Ithaca, N. Y.
Cornell Farm Mechanics Bulletin, Knots and Hitches

NOTE: All the bulletins and circulars except those of separate states, can be had free of cost by addressing your local congressman or the Secretary of Agriculture, Washington, D. C.

Among desirable periodicals for the school library are the following: The *Scientific American*, *Popular Mechanics*, and the *Patent Office Gazette*. The last-named publication can be procured free of cost by application to the district congressman or one of the U. S. Senators for New York. Every issue of the *Gazette* contains descriptions of several patented improvements on farm machinery.

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